No. 824,474. PATENTED JUNE 26, 1906.

W. W. FRENCH.

PYROMOTOR.

APPLICATION FILED JULY 1, 1905.

3 SHEETS—SHEET 1.

Fig. 1.

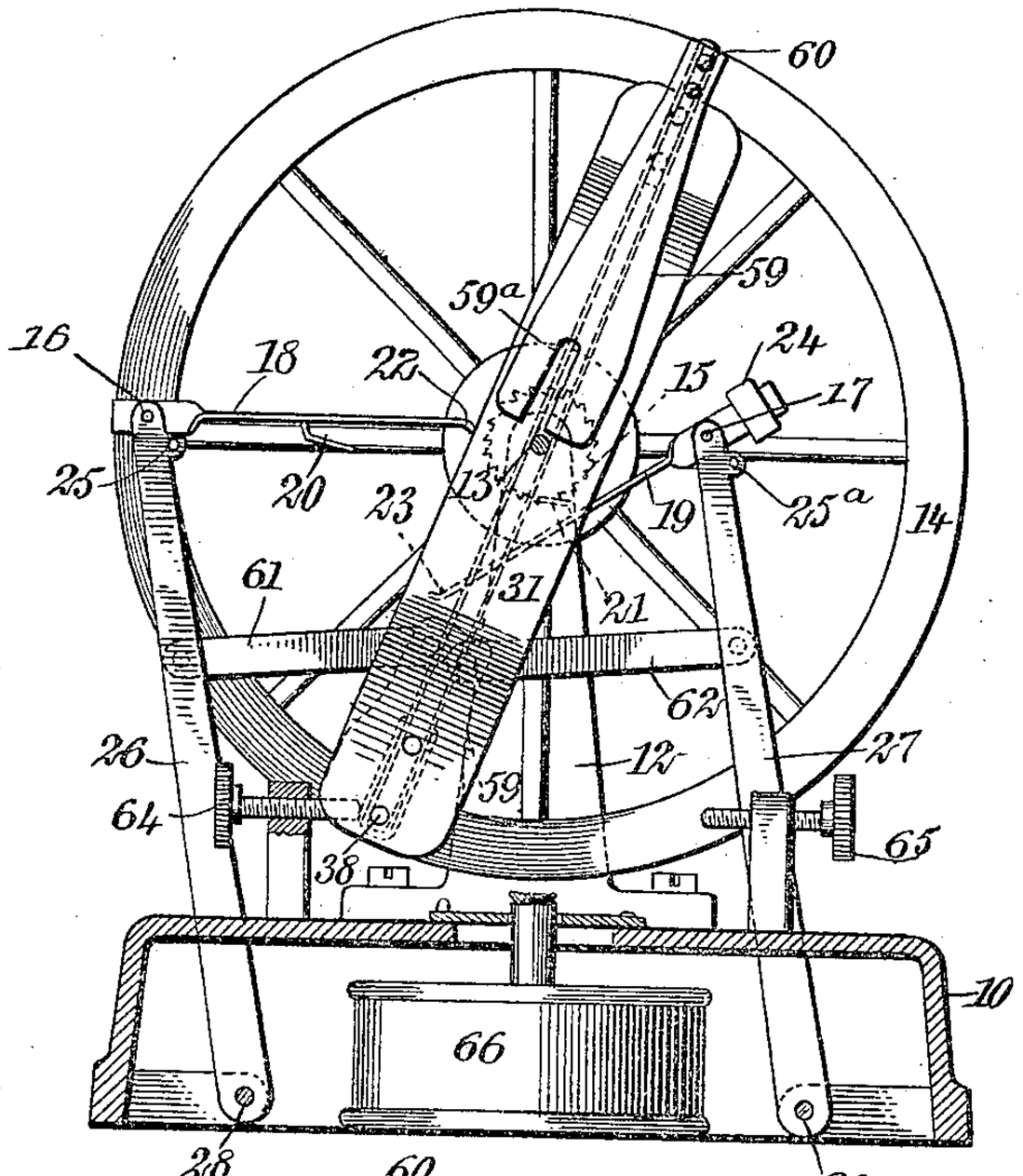
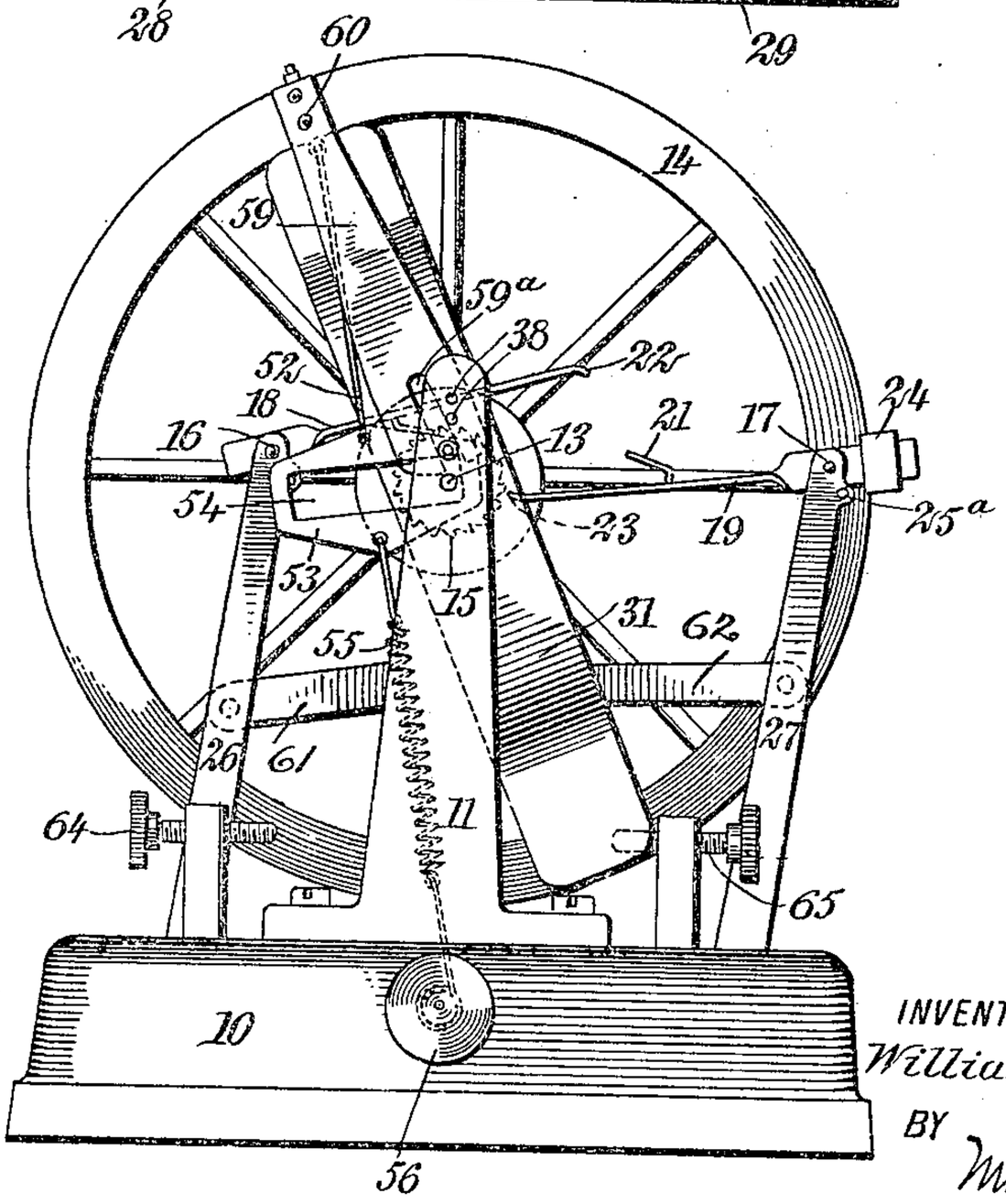


Fig. 2.



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3 SHEETS—SHEET 2.

Fig. 3.

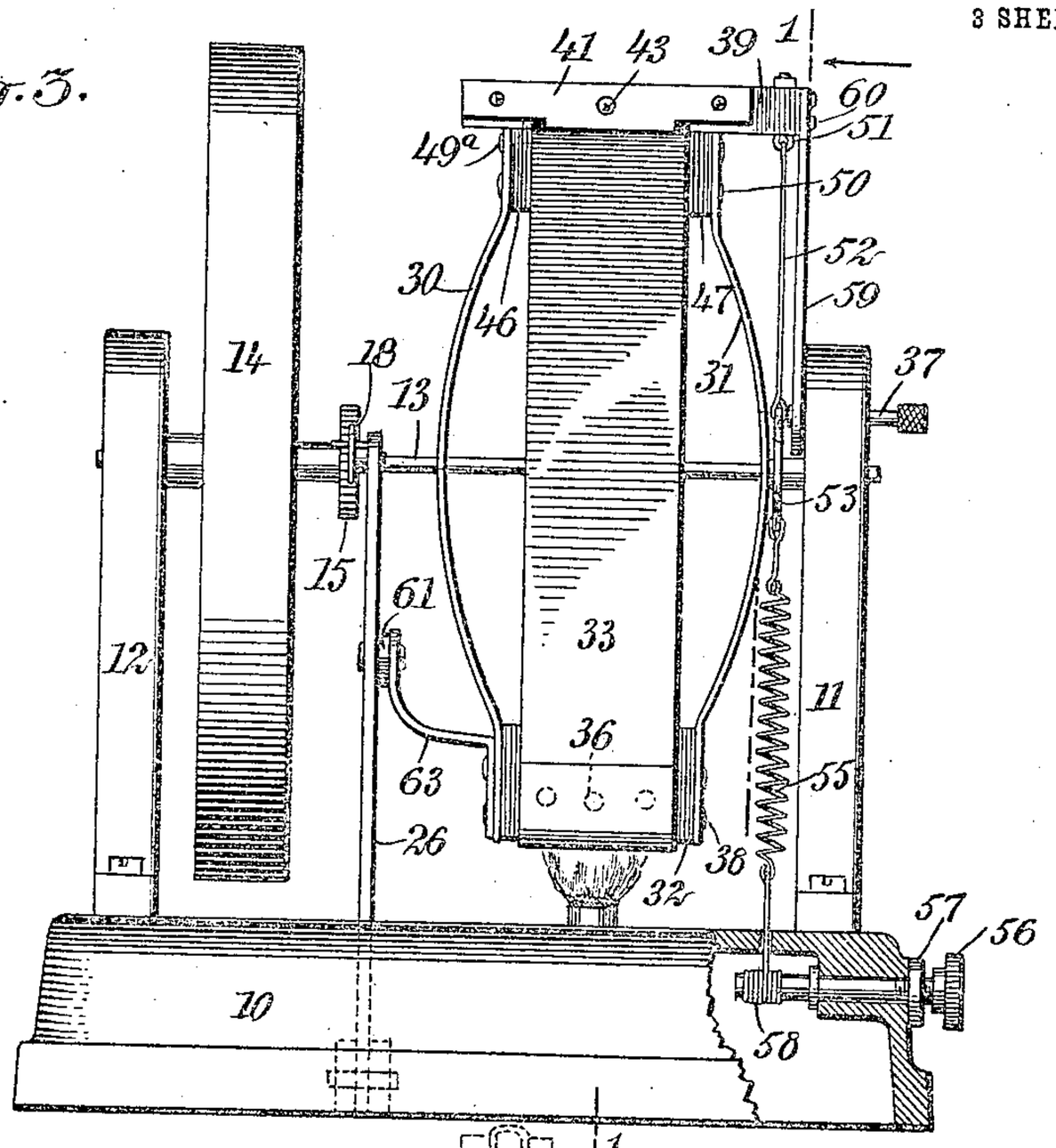
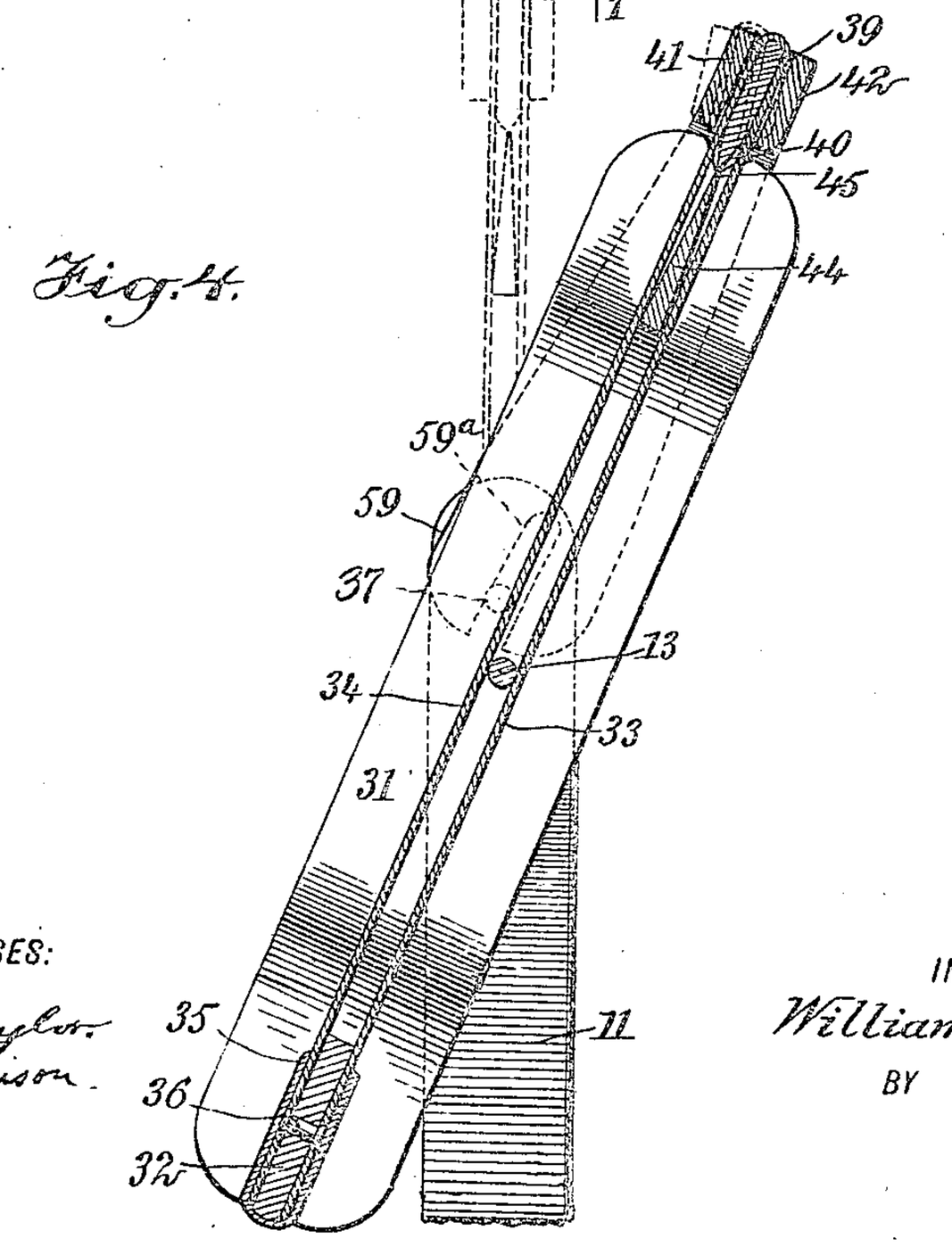


Fig. 4.



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3 SHEETS—SHEET 3.

Fig. 5.

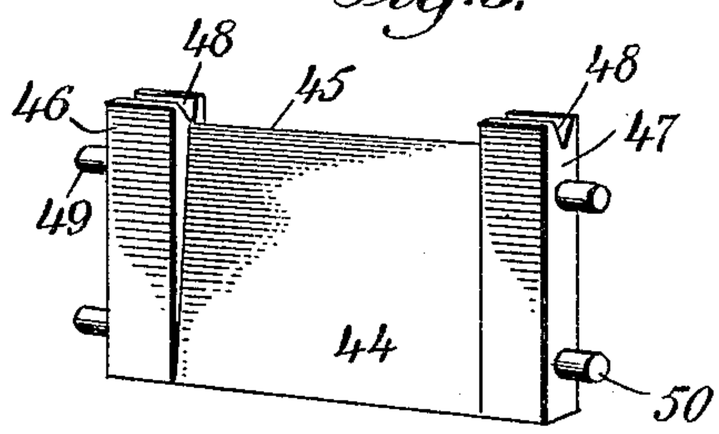


Fig. 6.

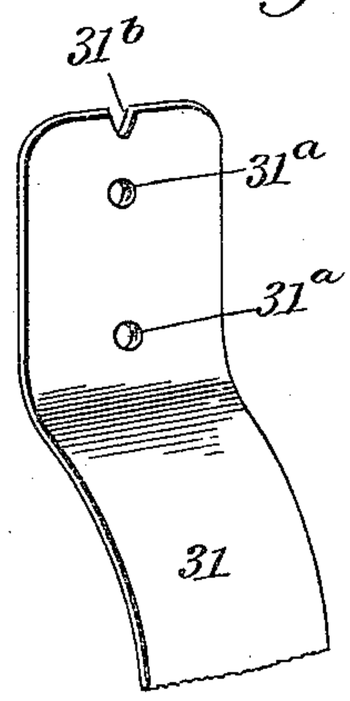


Fig. 8.

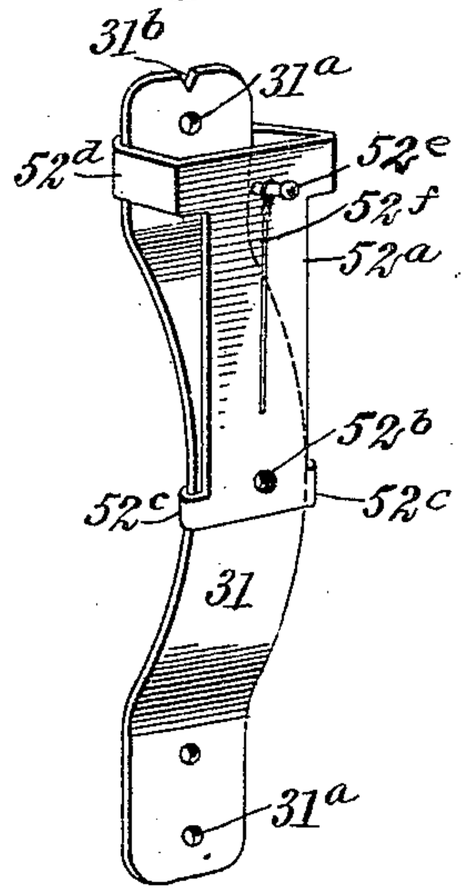


Fig. 7.

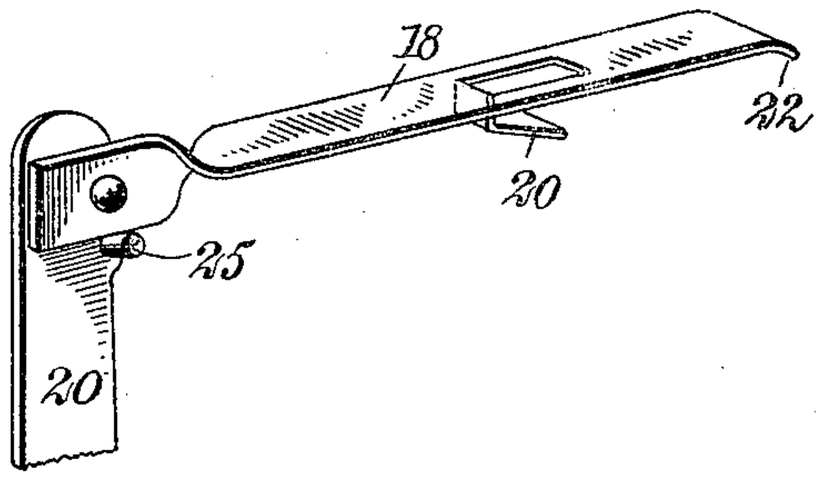
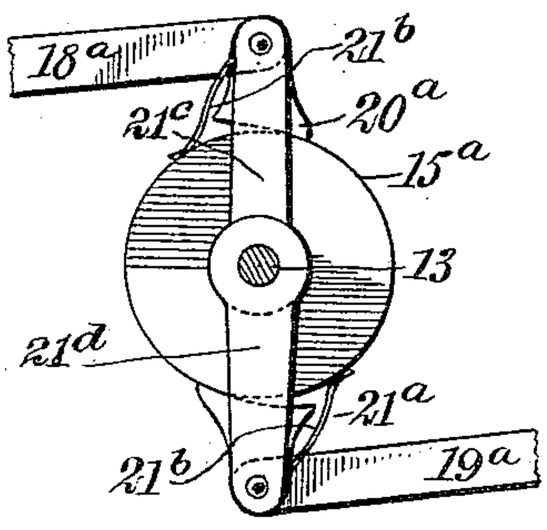


Fig. 9.



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UNITED STATES PATENT OFFICE.

WILLIAM W. FRENCH, OF FORT BRANCH, INDIANA.

PYROMOTOR.

No. 824,474. Specification of Letters Patent. Patented June 26, 1906.

Application filed July 1, 1905. Serial No. 267,868.

To all whom it may concern:

Be it known that I, WILLIAM W. FRENCH, a citizen of the United States, and a resident of Fort Branch, in the county of Gibson and State of Indiana, have invented a new and Improved Pyromotor, of which the following is a full, clear, and exact description.

My invention relates to motors, my more particular object being to produce a motor controlled directly by heat upon the principle of the expansion and contraction of one or more metallic members.

My invention further relates to means whereby the expansion and contraction of the metallic members or member is caused to produce an appreciable degree of motion.

My invention also relates to certain adjustments and combinations of parts whereby the efficiency of the construction is improved.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the figures.

Figure 1 is a vertical section upon the line 1 1 of Fig. 3 looking in the direction of the arrow and showing the principal working parts of the motor ready for use. Fig. 2 is a front elevation showing certain movable parts occupying positions different from those they occupy in Fig. 1. Fig. 3 is a side elevation showing the motor as seen from the left of Fig. 2, the adjustments 64 65 being removed for the sake of clearness. Fig. 4 is an enlarged central elevation through the expansion-strips and their accompanying parts. Fig. 5 is an enlarged perspective view of a block which is riveted firmly to the upper ends of the leaf-springs. Fig. 6 is an enlarged fragmentary perspective view of one of the tension-springs for tightening the expansion-strips. Fig. 7 is an enlarged perspective view of the upper pawl 18 and the rocking beam for actuating the same. Fig. 8 is a perspective view showing a different form of support for the off-center spring 55, and Fig. 9 is a fragmentary section showing a different form of pawl mechanism for rotating the fly-wheel 14.

My invention is based upon the principle that a strip of metal when heated becomes elongated and when allowed to contract against a resistance or, in other words, when made to do work in contracting it always exerts in the shape of useful work a quantity of energy commensurate with the heat energy absorbed in causing its expansion, due allowance being made for the loss from rotation and the like.

My invention involves the further principle that when a metallic strip or other member is thus heated to contract and perform useful work the work in question can be rendered more available for practical purposes by multiplying or amplifying the degree of movement produced by the contraction of the member, thus avoiding or reducing to a minimum the diminution in available work energy due to lost play or to imperfect fitting of the several parts.

Mounted upon a base 10 are bearing-standards 11 12, supporting a shaft 13, on which is loosely mounted a fly-wheel 14, provided with a hub to which is secured a ratchet-wheel 15, so that rotation of the ratchet-wheel 15 causes rotation of the fly-wheel. The fly-wheel is used in the ordinary capacity of a fly-wheel and also as a band-wheel for transmitting power to the machinery to be driven. By means of pivot-pins 16 17 a pair of pawls 18 19 are supported in working relation to the ratchet-wheel 15. These pawls are provided with jaws 20, 21, 22, and 23. When the pawl 18 is pushed toward the center of the machine, the jaw 22 first engages the ratchet-wheel 15 and turns the same a little distance, after which the jaw 20 engages the ratchet-wheel and continues its rotation in the same direction. When, however, the pawl moves in the reverse direction, the two jaws 20 22 are successively disengaged from the ratchet-wheel, as indicated in Fig. 1. The pawl 19 is provided with a counterweight 24, by the action of which it is pressed into gentle engagement with the lower side of the ratchet-wheel 15, its action being analogous to that of the pawl 18, as will be understood from Figs. 1 and 2. The pawls 18 19 therefore act alternately upon the ratchet-wheel 15, which in turn gives a double thrust, as it were, so as to increase to a maximum the motion of the wheel 14 for a given amount of movement of the pawls. Stop-pins 25 25^a hold the pawls in substantially horizontal positions, so as to render them readily available for catching a grip upon the ratchet-wheel. A pair of rocking levers 26 27 are pivoted, respectively, at 28 29 and serve to actuate the pawls. Threaded loosely upon the shaft 13 are leaf-springs 30 31, provided at their tops and bottoms with holes 31^a and, further, provided at their tops

with V-shaped notches or recesses 31b, as indicated in Figs. 6 and 8. These springs are connected rigidly together at their bottoms by a block 32 of metal. Expansion-strips 33 34 of metal are mounted together, preferably in the form of an integral member, as indicated in Fig. 4, their lower ends being secured to the block 32 and, together with this block, are encircled by a U-shaped shield 35 and are connected with each other and with the block 32 by means of rivets 36. The shield 35 not only serves to prevent displacement of the parts within it, but also prevents injury to these parts from excessive heat. The rivets 36 are secured rigidly in position, so as to prevent any relative movement as between the blocks 32 and the expansion-strips 33 34. An adjusting-pin 37 is associated with a number of holes 38 in the bearing-standard 11 and may be moved from one of these holes to another at will. Mounted between the strips 33 34 and partially encircled thereby is a block 39, provided with a knife-edge 40 and clamped rigidly upon the expansion-strips 33 34 by means of clamping-plates 41 42 and rivets 43, which pass directly through all of the parts just mentioned. A bearing-block 44 (see Fig. 5) is provided at its upper edge with a bevel 45 and at its ends with thick portions 46 47, these portions being provided, respectively, with V-shaped notches 48, serving as bearings, and with rivet-pins 49 50. The arrangement of the bearing-block 44 relatively to the knife-edge 40 may be seen from Fig. 4. A motor-arm 59 is connected rigidly by means of rivets 60 with a block 39. This motor-arm is provided with a slot 59a, which neatly engages the adjusting-pin 37.

When the parts are assembled, as indicated in Fig. 4, the leaf-springs 30 31 press the block 39 upward and tend to stretch the expansion-strips 33 34, whereas the tension of these strips maintains the knife-edge 40 in constant engagement with the V-shaped notches 48 and with the upper edge 45 of the block 44. The relation of the knife-edge 40 and the V-shaped bearings 48 and the edge 45 is such as to readily allow the block 39 to rock slightly each time the spring-frame vibrates, as will be hereinafter described—that is to say, the block 39, while maintained substantially in alinement with the block 44, is nevertheless adapted to careen slightly in relation to the block 44, and this occurs without any lost motion. When, therefore, one of the expansion-strips—say 33—becomes slightly longer than the other, owing to the different degrees of heat to which they are subjected, the block 39 tends to bend slightly into the position indicated by dotted lines in Fig. 4. As the upper end of the motor-arm 59 is rigidly connected with the block 39 and the slot in the lower end of said arm engages the fixed pin 37, the tension on the block 39 causes the entire frame to vibrate to the opposite side. During this movement the angularity of the motor-arm 59 is changed in relation both to the spring-frame and to the fixed pin, and the block 39 is rocked or careened without disturbing the position of the block 44, which is held steadily by tension of the leaf-springs 30 and 31. This movement of the block 39 takes place with a minimum of friction and without displacement as between the blocks 39 and 44. As the leaf-springs 30 31 are always under more or less tension, it follows that the expansion-strips 33 34 are likewise under more or less tension, so that any difference in expansion or contraction of either of the strips 33 or 34 is at once felt by the block 39 and manifested by a tendency to change the angular position of this block relatively to the block 44, the latter being held securely, as above described.

In assembling the rivet-pins 49 and 50 are simply passed through the holes 31a in the leaf-springs 31 and headed down so as to form headed rivets 49a and 50a, as indicated in Fig. 3. Mounted upon one end of the block 39 is an eye 51, as indicated at the right of Fig. 3. Supported by this eye is a rod 52, sustaining a link 53, the latter being provided with a slot 54, so as to encircle the shaft 13. This allows the link 53 to swing as indicated in Fig. 2. An off-center spring 55 is provided with a revoluble headed stem 56, carrying a jam-nut 57, whereby it may be held in definite position. A cord 58 is partially wound upon the stem and is connected with the off-center spring 55, so that the tension of the off-center spring may be adjusted at will. Pitmen 61 62 are pivoted upon the rocking levers 26 27 and are also pivoted, respectively, upon a bracket 63, the latter being in turn riveted rigidly upon the block 32, as will be understood from Figs. 1 and 3. Adjusting-screws 64 65 serve as limiting-stops for the shield 35 at the lower end of the expansion-strips 33 34 and serve, therefore, to limit the degree of motion. These adjusting-screws are moved by hand and may be thus caused to limit the speed of the motor. A lamp is shown at 66 and is used for heating the expansion-strips 33 34. If desired, instead of supporting the link 53 upon the rod 52 a bracket 52a may be used. This bracket is provided with a hole 52b, encircling the shaft 13, and with clips 52c 52d, whereby it is held upon the spring 31. Projecting outwardly from the bracket 52a is a pin 52e, which is connected by a rod 52f with the link 53. The action of the pin 52e is practically the same as that of the eye 51. It serves merely as a support for the off-center spring 55.

The pawls 18 19 (see Fig. 9) may be replaced by rods 18a 19a, provided with dogs 20a 21a, which engage a smooth wheel 15a, mounted rigidly upon the shaft 13 instead of upon the ratchet-wheel 15. Springs 21b are

used for maintaining the dogs 20^a 21^a in proper working relation to the smooth wheel 15^a. Two cranks 21^c 21^d, adapted to rock independently, connect the rods 18^a 19^a together and carry the respective dogs 20^a 21^a. Motion being given to the rods 18^a 19^a in the same manner that the motion is given to the pawls 18 19, the wheel 15^a is moved first by one dog and then by the other, the general action of the machine being the same as elsewhere described.

The operation of my device is as follows: The lamp 66 being lighted, the expansion-strips 33 34 are automatically exposed alternately to the action of the heat and are thus caused to contract and expand so as to give motion to the moving parts. Supposing the machine is in the position indicated in Fig. 1, the expansion-strips 33 34 will then be in the position indicated in Fig. 4, the block 39 being inclined slightly toward the right. The heat being applied to the expansion-strip 33, the latter becomes elongated and tends to cause the block 39 to careen slightly or to move in an arc around the knife-edge 40, as indicated by dotted lines in Fig. 4. This strain on the block 39 tends to cause the arm 59, which is rigid relatively thereto, to move at an angle upon an imaginary center passing through the block 39—that is, the motor-arm 59 tends to swing to the right from its position indicated in Fig. 4. As the slot 59^a fits neatly upon the adjusting-pin 37, however, the effort of the arm 59 to swing to the right causes the arm to press laterally against the pin 37 in a direction such as would tend to move this pin to the right according to the view shown in Fig. 4. The pin 37 being unable to move, the pressure exerted upon the block 39 causes the arm 59 and the entire member consisting of the expansion-strips 33 34, the leaf-springs 31, the blocks 39, 44, and 32, and other parts immediately connected therewith considered as a unit to swing into the opposite direction—that is to turn in a direction which would be expressed as contra-clockwise according to the view shown in Fig. 1. During this movement whenever the slot 59^a happens to be momentarily in exact alinement with the shaft 13 the block 39 will be directly over the shaft 13 and over the adjusting-pin 37, as indicated by dotted lines in Fig. 4. The expansion-strips 33 and 34, together with their immediate connections, may therefore be considered as a swinging beam of composite structure and from which motion is transmitted to the machinery. The swinging of this beam being understood, it is easy to see that the pitmen 61 62 must convey motion to the rocking levers 26 27, and these in turn acting through the pawls, as above described, must cause the rotation of the ratchet-wheel 15 and the fly-wheel 14. The beam being swung into the position indicated in Fig. 2 and the block 39 being inclined slightly toward the left, the heat of the lamp next causes the expansion-strip 34 to become elongated, which tends to move the block 39 in a direction reverse to that above mentioned, and the process is repeated, so that the beam swings back into its original position. (Indicated in Fig. 4.) It will be seen that, owing to the close proximity of the adjusting-pin 37 to the shaft 13, a comparatively slight angular movement of the motor-arm 59 suffices to throw the beam to a considerable angular distance. In other words, the rocking movement of the beam upon the shaft 13 is considerably greater than the virtual swing or angular movement of the motor-arm 59 upon an imaginary line passing through the block 39. The result is that an infinitesimal degree of elongation or contraction of the expansion-strips 33 34 causes the beam to swing to a considerable distance, and this adds to the rapid motion of the wheel 14. In thus multiplying the speed I am guided to some extent by the fact that one of the difficulties to be overcome in applying the expansion or contraction of metals to the driving of machinery is the small degree of expansion developed, even though considerable power be exerted in such expanison. By moving the adjusting-pin 37 upward or downward the speed and power of the motor may be varied. The nearer the pin 37 is placed to the shaft 13 the greater becomes the length of stroke of the beam, other things being equal. The adjusting-screws 64 65 may also be used for adjusting the throw of the beam. The best results are usually attained by first adjusting the pin 37 and then adjusting the screws 64 65 to such an extent as merely to prevent excessive movement, which might otherwire occasionally occur. The off-center spring 55 is to prevent the immediate return of the beam after oscillating in either direction—that is to say, the action of the motor is more efficient if the expansion-strips be exposed to the flame for a sufficient length of time to become very hot. The off-center spring causes the beam to "dwell" for a moment in each of its extreme positions. This also increases the radiation from the strip, which happens for the moment to be removed from the flame, and in a practical way increases the general working qualities of the motor.

Having thus described my invention, I claim as new, and desire to secure by Letters Patent—

1. In a pyromotor, the combination of expansion-strips pivotally mounted to swing bodily and together, means for alternately heating the expansion-strips, a member connected with said expansion-strips and on which the force of the expansion and contraction of said strips is exerted, the said member tending to careen slightly in consequence of said expansion and contraction, and an arm

rigidly connected at one end with said member and engaging at its other end a stationary device on which the arm is adapted to move, to cause the expansion-strips to swing bodily, and mechanism driven by the swinging movement of the expansion-strips.

2. In a pyromotor, the combination of a driven member, expansion-strips pivotally mounted to swing bodily and together, means for alternately heating the expansion-strips, a rocking member connected with said expansion-strips and on which the force of the expansion and contraction of said strips is exerted, a motor-arm connected with said rocking member, a stationary member engaged by the motor-arm, whereby the strain exerted on said rocking member causes the motor-arm to move on the said stationary member and the expansion-strips to swing bodily on their pivot, and mechanism connected with the expansion-strips and with the member to be driven.

3. In a pyromotor, the combination of expansion-strips, means for alternately heating said strips, a member connected with said expansion-strips and tending to careen angularly in relation thereto when acted upon by the expansion and contraction of said strips, a motor-arm connected with said member and provided with a slot, a stationary pin mounted within said slot, and mechanism connected with said expansion-strips and driven thereby for the purpose of propelling movable parts.

4. In a pyromotor, the combination of a frame, a revoluble driven member mounted thereon, a rocking lever provided with mechanism for causing said member to rotate, expansion-strips mounted to swing bodily and adapted to become elongated in consequence of heat and to contract when cooled, means for alternately subjecting the expansion-strips to heat, means for causing said expansion-strips to swing bodily when heated, and mechanism connecting said expansion-strips with said rocking lever.

5. The combination of a frame, a shaft mounted therein, a wheel mounted loosely upon the shaft, rocking levers each provided with mechanism engaging said wheel alternately to cause the same to rotate, a beam carried by the shaft and mounted to swing bodily, the said beam being provided with expansion-strips, means for alternately heating the expansion-strips, means for causing said beam to swing bodily when the expansion-strips are heated, and links connecting the said beam with the rocking levers.

6. In a pyromotor, the combination of springs mounted to oscillate, a block connected thereto and provided with bearing portions, another block provided with a knife-edge engaging said bearing portions, expansion-strips connected with said last-mentioned block and with said springs so as to force said last-mentioned block tightly against said bearing portions, means for alternately heating the expansion-strips, a motor-arm connected with said last-mentioned block and adapted to move to divers angles relatively to said springs, a stationary member engaged by said motor-arm to permit said arm to shift itself into different angular positions thereby causing the springs and the parts carried thereby to oscillate, and mechanism connected with said springs for translating motion therefrom to the mechanism to be driven.

7. In a pyromotor, the combination of a driven member, a swinging beam provided with expansion-strips, means for heating the said strips, the strips being alternately subjected to heat, means for causing the beam to oscillate through the expansion of the strips, means for actuating the driven member from the swinging beam, and means for adjusting the swing of said beam.

8. In a pyromotor, the combination of a supporting-frame, expansion-strips mounted to oscillate in the frame, means for heating the expansion-strips, the said strips being alternately subjected to the heat, a rocking member connected with the expansion-strips, a motor-arm connected with the rocking member, a stationary member engaged by said motor-arm and forming a resistance to said arm, to permit the arm to swing under the action of the expansion-strips, and thereby impart a swinging movement to said expansion-strips, means for adjusting said stationary member to regulate the swing of said motor-arm, a driven member mounted in the supporting-frame, and a driving connection between the expansion-strips and said driven member.

9. In a pyromotor, the combination of a beam, a source of heat, the beam being provided with expansion-strips and mounted to swing bodily whereby the expansion-strips may be alternately subjected to the action of the heat, means for causing the beam to swing when the expansion-strips are heated, and mechanism driven by the swinging movement of said beam.

10. In a pyromotor, the combination of a beam, a source of heat, the beam being provided with expansion-strips and mounted to swing bodily whereby the expansion-strips may be alternately subjected to the action of the heat, mechanism for causing the beam to swing when the expansion-strips are heated, rocking levers connected with said beam and actuated by the movements thereof, a shaft, a fly-wheel mounted loosely on the shaft, a ratchet-wheel secured to the hub of the fly-wheel, and ratchet mechanism connected with said rocking levers and with said ratchet-wheel for conveying motion to the latter and the fly-wheel.

11. In a pyromotor, the combination of a

frame provided with standards, a shaft mounted in the standards, a swinging beam comprising leaf-springs mounted loosely upon said shaft, blocks connecting the ends of said springs together, the block connecting the upper ends of said springs being provided with notches, expansion-strips connected at their lower ends with the block at the lower ends of the springs, and a rocking member connected with the upper portion of said expansion-strips and provided with a bearing-surface engaging the notches in the said upper block, said expansion-strips being rendered tight by said springs, a motor-arm connected at its upper end with said rocking member and adapted to move to different angles, a stationary pin engaged by the lower portion of said arm and against which the arm is adapted to press, means for alternately heating the expansion-strips to cause strain on the rocking member, thereby causing the swinging beam to oscillate, and mechanism driven by the movement of the swinging beam.

12. In a pyromotor, the combination of a swinging member provided with expansion-strips, means for applying heat directly to said strips alternately, means by which the swinging member is caused to oscillate through the expansion of the strips, a driven member, mechanism connected with said swinging member for transmitting motion to said driven member, and an off-center spring connected with said swinging member.

13. In a pyromotor, the combination with a revoluble driven member, a swinging member provided with expansion-strips for absorbing and radiating heat, a source of heat for heating said expansion-strips, means by which the swinging member is caused to oscillate through the expansion of the strips, the said strips being exposed alternately to the action of the heat by the swinging of said member, an off-center spring connected with said swinging member for causing the same to dwell momemtarily in its extreme positions, and mechanism connected with said swinging member for actuating said driven member.

14. A pyromotor, comprising expansion-strips mounted to oscillate, means for alternately heating the strips, a rocking member connected with the expansion-strips and on which the force derived from the expansion and contraction of said strips is exerted, means for utilizing the power exerted on the said rocking member to cause the expansion-strips to oscillate, and mechanism driven by the oscillation of said expansion-strips.

15. A pyromotor, comprising a wheel mounted to turn, expansion-strips mounted to oscillate, means for alternately heating the strips, a member connected with the expansion-strips and on which the force derived from the expansion and contraction of said strips is exerted, means for utilizing the strain exerted on the said member to cause the expansion-strips to oscillate, and means for driving the said wheel by the oscillating movement of the expansion-strips.

16. A pyromotor comprising expansion-strips, heating means to which the strips are alternately subjected, a shaft on which the strips are mounted to oscillate, a member connected with the expansion-strips and on which the force derived from the expansion and contraction of said strips is exerted, means connected with said member by which the force exerted on the latter is caused to oscillate the expansion-strips, means for varying the length of stroke of the oscillating strips, and mechanism driven by the oscillating movement of said expansion-strips.

17. A pyromotor comprising a frame, a shaft on which the frame is mounted to oscillate, expansion-strips carried by said frame, heating means to which the expansion-strips are alternately subjected, a rocking member connected with the expansion-strips and on which the force derived from the expansion and contraction of said strips is exerted, an arm connected with said rocking member, a pin engaged by said arm, the said pin being adjustable toward and from the said shaft, to vary the length of stroke of the oscillating frame, and mechanism driven by the movement of said frame.

18. In a pyromotor, expansion-strips, a shaft on which said strips are mounted to oscillate, a rocking block connected with the upper ends of said expansion-strips and on which the force derived from the expansion and contraction of said strips is exerted, a motor-arm connected at its upper end with said rocking block, a stationary member located adjacent to the said shaft, and engaged by the lower end of said motor-arm, the said motor-arm remaining constantly in contact with the said stationary member, the said arm being adapted to move to different angular positions and the said rocking block careening slightly at each oscillation of the said expansion-strips, means for subjecting the expansion-strips alternately to heat, whereby the strain on the rocking block causes the expansion-strips to oscillate, and means for transmitting motion from the said oscillating strips.

19. In a pyromotor, a shaft, a frame mounted to oscillate on the shaft and provided with expansion-strips, a rocking block connected with the upper ends of said expansion-strips, a motor-arm connected at its upper end with said rocking block, and having a slot in its lower end, a pin engaged by the slotted end of said motor-arm, the said pin being in vertical alinement with the shaft and adjustable toward and from the same, a source of heat to which the expansion-strips are alternately subjected, thereby causing the frame

to oscillate, and mechanism driven by the oscillation of said frame.

20. A pyromotor comprising heating means, expansion-strips mounted to swing bodily, whereby the strips may be alternately subjected to the action of the heat, means for causing the expansion-strips to swing bodily when heated, and mechanism driven by the swinging movement of said strips.

21. In a pyromotor, the combination of a driven member, a device mounted to swing bodily and having members adapted to become elongated when heated, means for heating the said members alternately, means for causing the said device to swing bodily through the expansion and contraction of said members, and means for actuating the driven member from said device.

22. A pyromotor, comprising heating means, a device mounted to oscillate and having portions expanding when heated and adapted to be alternately subjected to the action of the heat, means for utilizing the force exerted by the expansion and contraction of said portions to cause the device to oscillate, and means for transmitting power from the said oscillating device.

23. In a pyromotor, heating means, a device mounted to oscillate bodily in a vertical plane above said heating means and having members adapted to be alternately subjected, by the oscillation of the device, to the action of the heat, the said members being adapted to become elongated when exposed to the heat and to contract when removed from exposure to the heat, a rocking block connected with the members of said device and on which the force of the expansion and contraction of said members is exerted, means connected with the rocking block for utilizing the power exerted thereon to cause the said device to oscillate, and means for transmitting motion from the oscillating device.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM W. FRENCH.

Witnesses:
JOHN N. DELONG.
J. L. BROKAW.